On correlated change in personality

Allemand, Mathias ; Martin, Mike

Abstract: Correlated change in personality is essential to understanding change and development. It refers to the question of whether and to what degree changes in personality are interrelated over time within and between individuals. Compared to the longstanding literature on personality development, relatively less research has focused on correlated change in personality. The main goal of this paper is thus to discuss the potential of this concept for the field of personality development. First, we define correlated change and propose a categorization framework with multiple dimensions. Second, we discuss several theoretical concepts of correlated change that help understand the patterns, causes, and mechanisms underlying correlated change in personality. Third, we briefly describe several statistical approaches to modeling correlated change. Fourth, we summarize previous research on correlated change in personality. We focus our research on (a) correlated change within the Big Five personality traits, and (b) between the Big Five personality traits and three domains of life. Finally, we conclude by discussing challenges and future directions of the concept for the field of personality development.

DOI: https://doi.org/10.1027/1016-9040/a000256

Running head: CORRELATED CHANGE IN PERSONALITY

On Correlated Change in Personality

Mathias Allemand & Mike Martin

Department of Psychology & URPP "Dynamics of Healthy Aging"

University of Zurich

***European Psychologist*, in press**

Author's Note

Correspondence concerning this article should be addressed to Mathias Allemand, University of Zurich, Department of Psychology and University Research Priority Program "Dynamics of Healthy Aging", Binzmühlestrasse 14/24, CH-8050 Zurich, Switzerland (e-mail: m.allemand@psychologie.uzh.ch).

Abstract

Correlated change in personality is essential to understanding change and development. It refers to the question of whether and to what degree changes in personality are interrelated over time *within* and *between* individuals. Compared to the longstanding literature on personality development, relatively less research has focused on correlated change in personality. The main goal of this paper is thus to discuss the potential of this concept for the field of personality development. First, we define correlated change and propose a categorization framework with multiple dimensions. Second, we discuss several theoretical concepts of correlated change that help understanding the patterns, causes, and mechanisms underlying correlated change in personality. Third, we briefly describe several statistical approaches to modeling correlated change. Fourth, we summarize previous research on correlated change in personality. We focus on research on (a) correlated change *within* the Big Five personality traits, and (b) *between* the Big Five personality traits and three domains of life. Finally, we conclude by discussing challenges and future directions of the concept for the field of personality development.

On Correlated Change in Personality

Research in the field of personality development suggests that personality change and stability can be evaluated from multiple perspectives (cf. Roberts, Wood, & Caspi, 2008). For example, personality traits typically demonstrate relatively high levels of stability over time and across ages in terms of structural stability and differential or rank-order stability (Allemand, Zimprich, & Martin, 2008; Roberts & DelVecchio, 2000; Terraciano, Costa, & McCrae, 2006; Zimprich, Allemand, & Lachman, 2012). This implies that the positioning of traits relative to each other remains stable and is unaffected by age and aging, and those individuals maintain their ranking in a reference group over time. At the same time, personality traits demonstrate systematic mean-level changes and age-related differences from childhood to old age (Kandler, Kornadt, Hagemeyer, & Neyer, in press; Lucas & Donnellan, 2011; Marsh, Nagengast, & Morin, 2013; Nye, Allemand, Gosling, Potter, & Roberts, in press; Roberts, Walton, & Viechtbauer, 2006; Soto, John, Gosling, & Potter, 2011). This suggests that average trait scores of the groups have changed. Regardless of average mean-level change patterns, individuals may vary significantly in the degree and direction or patterns of change. Indeed, there is growing evidence for individual differences in personality development at all ages, suggesting unique patterns of change across the lifespan as the result of specific life experiences and exposure to different and varying environmental contexts (Mroczek & Spiro, 2003; Roberts & Mroczek, 2008; Specht, Egloff, & Schmukle, 2011).

An important perspective of change and stability that has received little attention in the field of personality development is *correlated change* (also called *specific versus general change*; Allemand, Zimprich, & Hertzog, 2007). Correlated change in personality is essential to understanding change and development and to uncover important mechanisms that potentially shape change and development (Hertzog & Nesselroade, 2003). It refers to the question of whether and to what degree changes in personality are interrelated over time *within* and *between* individuals. Are changes in personality related to better health or social

integration? How do changes in the environment such as rapid technological changes influence the development of personality? How do changes in my partner influence my own development? Which changes in personality and activities are needed to maintain my identity across the lifespan? Whenever we ask these questions, we ask questions about correlated change. This paper thus discusses the relevance of this novel perspective for the field of personality development. The first part refers to the definition of correlated change and it includes a categorization framework with multiple dimensions that will be used to organize the discussion of correlated change in personality. The second part discusses several theoretical accounts for correlated change in personality. The third part refers to the statistical modeling of correlated change and describes four modeling strategies that are typically used in this area of research. The fourth part briefly summarizes available empirical evidence for correlated change in personality and focuses on empirical evidence for correlated change within the Big Five personality traits and between the Big Five personality traits and three domains of life. The final part discusses challenges and implications of correlated change for the field of personality development and suggests directions for future research.

Defining Correlated Change

Commonality in Change

What are the patterns of cross-sectional correlations between the Big Five personality traits? This first question pertains to concurrent correlations that are patterns of associations between a set of variables at a certain point in time or single measurement occasion. How stable are the patterns of correlations between the Big Five traits across different measurement occasions? This second question refers to an important perspective of change and stability that is structural stability (e.g., Allemand et al., 2007; Small, Hertzog, Hultsch, & Dixon, 2003). The degree and patterns of concurrent correlations can be stable or change over time and across ages. Are longitudinal changes in the Big Five personality traits correlated and is there a commonality in the patterns of change, respectively? This third question refers

to correlated change and reflects a *dynamic* variant of the static concurrent correlations. Basically, correlated change indicates *whether* and *to what degree* change in one variable is related to change in another variable. It represents the correspondence between rates of change in at least two variables over time. Whereas structural stability addresses changes in time-specific interrelations between variables, correlated change provides evidence that changes in variables are systematically related to each other or even the change in one variable may be caused by the other variable. Change correlations can be positive and negative, and even if they are positive, the developmental change can be a very slight increase in one and a very strong in the other. Over time, at least within persons, there may be times of positive and times of negative correlations between changes.

The perspective of correlated change addresses the question of commonality in change across variables (cf. Hertzog & Nesselroade, 2003; McArdle & Nesselroade, 1994). If points of reference are assumed to be different between individuals but to remain stable within an individual across time, each individual may serve as his or her own control group. In that case, one can infer that the degree of correlated change represents the relationship between the variables in a way that is more precise and uncontaminated by initial differences. Note that whereas differential or rank-order stablity addresses the rank-order of change in a single variable, correlated change covers the amount of correspondence in rank-orders of change across two or more variables.

Are the patterns of cross-sectional correlations between the Big Five personality traits similar in the degree to the longitudinal correlated change patterns? This extra question is included to highlight a more restrictive variant of a correlated change model that would test for equality of concurrent correlations at the first measurement occasion, that is, initial level factor correlations and change factors correlations. Should equality hold, this would imply *"intercorrelations stationarity,"* that is, stability of the associations among the variables of interest over time (Allemand et al., 2008). Specifically, if the correlation between change

factors is used as an estimate of correlated linear change that would emerge if the longitudinal time span tended to infinity, it can be shown that the cross-sectional correlations among the factors approach the change factor correlations (cf. Hofer, Flaherty, & Hoffman, 2006).

A Categorization Framework

The concept of correlated change can be categorized along multiple dimensions[1]. Figure 1 includes four dimensions (time, person, domain, and method) that will be discussed in detail below. This framework will be used to organize the empirical literature on correlated change in personality and may inspire future research in this area.

Time. One important dimension is the *longitudinal interval*, as change can be correlated over different time intervals ranging from very short intervals, such as from moment-to-moment, a day, or a few weeks, to long intervals, such as across months, years, or even decades. *Long-term* correlated change refers to the commonality in *developmental* processes that occur over longer time periods (e.g., Allemand et al., 2008). For example, one can examine whether changes in agreeableness across several years may correspond to changes in social functioning such as interpersonal trust and cooperative behaviors and thus develop in a connected way. In contrast, *short-term* correlated change refers to commonality in *dynamic processes* over shorter time intervals. A good example for short-term correlated change would refer to correlated changes in emotional patterns and reactions between close relationship partners. Short-lived and varying emotional reactions may occur in a concerted way between relationship partners while a couple is discussing emotional charged topics such as work-family-balance and conflicts in the relationship. The concept of "emotional coregulation" (Butler & Randall, 2013), for instance, describes the bidirectional linkage of oscillating emotional channels between partners in close relationships. Moreover, correlated change can occur between processes that transpire over very different temporal intervals, as

[1] The proposed categorization framework can be transferred to any longitudinal data analyses and is not specific to the field of personality development.

short-term change or variability measured in repeated bursts of intensive (daily or momentary) assessments could be related to long-term developmental change (cf. Sliwinsky, 2008).

The timing and the number of time points or measurement occasions within a specified time interval requires attention with respect to correlated change. If the constructs under study demonstrate different distinct change trajectories and different shapes of change within different time intervals, then it would be useful to have more time points to better estimate the pattern and degree of correlated change. In contrast, if two processes take time to develop in a predictable linear way, then fewer time points are sufficient. The temporal interval that is needed to accurately capture systematic change in the constructs of interest and to determine correlated change, is an important developmental aspect. Longitudinal intervals that are too short or too long in relation to the nature of the phenomenon being studied can produce data that, in some cases, are overly sensitive to measurement errors and carryover effects and, in other cases, are insensitive to variability and change (cf. Biesanz, West, & Kwok, 2003; Hertzog & Nesselroade, 2003). In sum, the longitudinal interval is important in attempts to study correlated change, as short-term versus long-term change associations may have different underlying mechanisms and different implications.

Person. Psychological processes typically occur within individuals over time, but they also happen across individuals (cf. Fleeson, 2007). The first perspective focuses on correlated change *within* the person, which would result in consistent relative change or variability exhibited by an individual during a given time period on each of two or more variables. As such, *within-person* or *intra*individual correlated change reflects the extent to which the rates of two variables corresponds or "travel together" through time. Put differently, this perspective refers to the pattern and degree to which intraindividual change in one variable corresponds to intraindividual change in another variable *within* individuals. In the cognitive aging literature, Sliwinski, Hofer, and Hall (2003) used the term "coupled change" to describe

associations at the within-person level. For example, how individuals tend to react to threat, frustration, or loss in daily life may be related to changes in their daily affective experience and psychological adjustment. From a within-person level it is likely that increases in neuroticism over time may show commonality with increases in negative affective experiences.

The second perspective focuses on correlations of rates of changes in the population, which would result in *between-person* or *inter*individual correlations among the rates of change. Between-person correlated change indicates the pattern and degree to which variables change together over time *between* individuals. Sliwinski et al. (2003) used the term "correlated change" with respect to associations at the between person-level. A specific form of between-person correlated change—termed *co-development*—can be examined particularly in dyadic contexts. In this case, the question is whether and to what degree change in one partner corresponds to change in the other partner. For example, individuals within a romantic relationship may change aspects of their personality such as relationship-specific attachment orientations over short time periods in a similar way. Correlated or "coordinated" change between partners is consistent with the notion that romantic partners may react in similar ways to shared experience (Hudson, Fraley, Brumbaugh, & Vicary, 2014). In sum, whereas within-person correlated change addresses changes within individuals, between-person correlated change provides evidence for related changes between individuals. These two perspectives provide complementary views on the commonality or, in contrast, independence of change. This paper focuses primarely on *within-person* correlated change. For the sake of simplicity, in this paper we do not differentiate between the terms of correlated and coupled change (cf. Sliwinski et al., 2003).

Domain. Change can be correlated within a *single* domain of functioning, such as personality. As such, *within-domain* correlated change refers to change correlations with respect to different aspects or variables of the same specific domain, such as the Big Five

traits (e.g., Allemand et al., 2007). For example, one can examine whether changes in neuroticism are correlated with changes in conscientiousness or agreeableness over time. Change can also be correlated across *diverse* domains or life contexts, such as personality, health, work, and social relationships and thus refers to *between-domain* correlated change. As an example, one can then examine whether changes in neuroticism correspond to changes in specific characteristics of social relationships such as insecurity with family members (Neyer & Lehnart, 2007). In sum, whereas the within-domain correlated change addresses changes in one domain of functioning, between-domain correlated change provides evidence of variables across domains change in concert over time.

Method. The method of assessment is another important definitional feature. Change can be correlated within a *single* method. Hence, *within-method* (or mono-method) correlated change refers to change associations between two or more variables that are assessed with the same method, such as self-reports. Change can also be correlated across *diverse* methods. In this case, *between-method* (or mixed-method) correlated change reflects the degree to which variables assessed with one method such as self-reports are related to variables that are assessed with a different method such as observer reports. As an example, one can examine whether self-reported personality change is associated with partner-reported personality change (Watson & Humrichouse, 2006). In sum, whereas within-method correlated change addresses change associations with respect to a single or mono-method, between-method correlated change provides evidence of variables assessed across multiple, diverse methods travel together over time.

Conceptualizing Correlated Change

Patterns and Causes

From a developmental perspective, correlated change in personality may provide interesting insights into the patterns, causes, and underlying mechanisms of personality development. Understanding the patterns of change associations might help to uncover

important mechanisms that potentially shape change and development (Hertzog & Nesselroade, 2003). More specifically, the pattern and degree of correlated change in personality is an informative type of change and stability (i.e., general versus specific change; Allemand et al., 2007). It indicates whether personality development is predominately influenced by a few general, broadly acting mechanisms that operate simultaneously on multiple personality constructs, or by specific, narrowly acting mechanisms each affecting only one single personality construct (Allemand et al., 2007; Soto & John, 2012).

If changes in personality constructs were highly correlated, this would suggest very few general, broad mechanisms that affect the entire behavioral and experiential repertoire of individuals and thus are responsible for the individual changes observed. Broadly acting mechanisms would explain a similarly large degree of personality change in most individuals, implying that the same underlying causes of personality development, such as genetic factors, developmental processes, social roles, life events, social environments, and person-environment interactions (Caspi & Roberts, 2001; Fraley & Roberts, 2005; Kandler et al., in press; Roberts & Wood, 2006; Roberts et al., 2008; Wood & Denissen, 2015) would operate simultaneously on multiple personality constructs in the same way. Then it seems unlikely that those processes triggering personality changes influence single personality constructs in isolation. By contrast, low to moderate correlated changes among constructs—and also unrelated change associations—may reflect the possibility that changes are specific, narrow, and isolated. This would imply that the causes of change are different for each personality constructs and that individual and environmental processes affect personality constructs differently.

The developmental perspective of correlated change is largely understudied in the field of personality development, whereas it is more prominent in other fields, such as cognitive aging (e.g., Baltes & Lindenberger, 1997; Martin & Zimprich, 2003; Mascherek & Zimprich, 2011; Salthouse, 1996; Sliwinsky et al., 2003; Zimprich & Martin, 2002). In the cognitive

aging literature, the perspective of correlated change is strongly linked to common factor theories, such as the common cause hypothesis (Baltes & Lindenberger, 1997). These theories postulate that a single underlying common mechanism such as processing speed mediates a substantial portion of age-related influences on all cognitive abilities (Salthouse, 1996). In contrast to the field of cognitive aging, no specific theories of correlated change in personality currently do exist. However, a number of general, broadly acting mechanisms are discussed that are suitable theoretical accounts for correlated change in personality (cf. Allemand et al., 2007, 2008; Klimstra, Bleidorn, Asendorpf, van Aken, & Denissen, 2013; Soto & John, 2012). In the following, we discuss these ideas in detail.

Adjustment and maintenance. There are several theoretical reasons to expect correlated change *within* the domain of personality. Particularly the traits of agreeableness, conscientiousness, and emotional stability (low neuroticism) are discussed as sharing some commonality. First, Digmann (1997) suggests that these three traits are jointly influenced by the internalization of broad societal norms toward socially approved behavior. This *socialization* process reflects a broadly acting mechanism that would shape socially acceptable levels of personality traits. Second, commonality in change between agreeableness, conscientiousness, and emotional stability can be conceptualized more broadly as *adjustment* to developmental tasks of adulthood, including social roles in work, family, and community (Staudinger & Kunzmann, 2005). From a functional perspective, becoming more agreeable, conscientious, and emotional stable or put differently, becoming more mature—is adaptive for the individual and reflects qualities that serve to facilitate functioning in interpersonal relationships, social groups and communities (cf. Roberts & Wood, 2006; Wood & Denissen, 2015; Wood, Hensler Gardner, & Harms, 2015). Finally, DeYoung, Peterson, and Higgins (2002) point out that these three traits appear to reflect stability in emotional, social, and motivational domains. They argue that the *serotonergic system* is the underlying neurobiological mechanism that regulates behavioral and emotional impulses (DeYoung &

Gray, 2009; DeYoung et al., 2002). In sum, these theoretical ideas suggest that the adjustment to life experiences, social roles, and diverse environmental contexts, and the maintenance of emotional, social, and motivational stability reflect important common functions of personality development.

Personality growth. There are also several theoretical reasons to expect associations among changes in extraversion and openness to experience. For example, Digmann (1997) suggests that the underlying mechanisms for the commonality between the two personality traits can be interpreted as *personal growth* and *self-actualization*, which appears to reflect the tendency to explore or to engage voluntarily with novelty and may, as a consequence, be associated with plasticity or flexibility in behavior and cognition (cf. DeYoung et al., 2002). Similarly, Staudinger and Kunzmann (2005) argue that *growth* reflects increases in certain virtues such as insight, integrity, self-transcendence, and the striving toward wisdom. It implies that personality development transcends the given societal circumstances as personality growth (cf. Staudinger & Kunzmann, 2005). Finally, DeYoung et al. (2002) claim that the *dopaminergic system* is the underlying neurobiological mechanism that promotes behavioral and cognitive exploration and thus might simultaneously affect extraversion and openness to experience (DeYoung & Gray, 2009; DeYoung et al., 2002). In sum, these theoretical ideas suggest that the adaptation to novelty, change, and growth reflect important common functions of personality development.

Dynamic transactions. Dynamic transactional perspectives are useful theoretical accounts particularly with respect to correlated changes *across* different domains, such as personality and social functioning, but also *between* different individuals, such as relationships partners (e.g., parents, siblings, children, peers, or romantic partners). Transactional perspectives highlight the development of the individual in relation to contextual, environmental, sociocultural influences, and changes across the lifespan (cf. Caspi & Roberts, 2001; Fraley & Roberts, 2005; Roberts et al., 2008; Wood & Denissen, 2015).

Transactional views suppose that individuals are active agents who play an important role in selecting and shaping their environment in ways that suit their personalities, and these environments, in turn, affect their personalities. In other words, what an individual brings to the context with his or her personality shapes and changes the context itself, which, in turn, may also influence the individual. In addition to the selection or creation of environments consistent with one's personality, traits may influence how other individuals are perceived and responded to. Eventually, an individual's traits may also evoke distinct reactions from others (cf. Roberts et al., 2008).

As social relationships are part of an individual's environment (e.g., Schaffhuser, Allemand, & Martin, 2014), this also implies that there are reciprocal transactions between personality and relationship experiences (Graber, Laurenceau, & Carver, 2011; Neyer, Mund, Zimmermann, & Wrzus, 2014). Such dynamic processes are called personality-relationship transactions. Correlated change reflects a kind of such transactions through which the cumulative stability of both personality and relationships may come about (Neyer & Lehnart, 2007). In sum, transactional views suggest that dynamic transactions between individuals and their environment are responsible for personality development.

Personal constructs. The personal construct theory (Kelly, 1955) is a first example of a transactional view on personality development. Kelly (1955; see Walker & Winter, 2007 for an elaboration of personal construct psychology) theorized that humans are scientists and through interacting with the environment learn about behavior-environment contingencies and differentiate their representation of person-environment contingencies. The more differentiated and integrated the representation, the more flexible the person is to respond to contextual variation. For instance, at a low level of integration a person may either spit in public or not. At a higher level of integration, the person will first determine if spitting in a particular environment is considered impolite or rude or if it is culturally expected. A person with higher levels of agreeableness will rather be polite in both cultures, i.e., spit in one and

not in the other. Both seemingly contradictory behaviors are indicators of the same trait. This suggests that the more integrated the representation of person-environment contingencies, the more similar the representation will be, but the more different behaviors it allows. Thus, we would expect strong correlated change in the higher order representations (such as in traits), and (a) practically no correlated change in observable behaviors if the environment constantly changes or (b) increasingly strong correlated changes the more regular and predictable the environment changes.

Social investment. The social investment theory (Roberts, Wood, & Smith, 2005) is a second example of a transactional view on personality development. This theory proposes *social investment* as a general process to explain why individuals become more socially dominant, agreeable, conscientious, and emotionally stable—or as mentioned earlier in other words, more mature—with age. Roberts et al. (2005) suggest that investment in, and commitment to normative, age-graded social roles of adulthood (e.g., completing education, starting a career, having a family, participating in community activities) is a key driving mechanism for personality development, and maturity in particular (Lodi-Smith & Roberts, 2007; Roberts & Wood, 2006). One claim is that successful fulfillment of roles often demands certain behaviors and characteristics. Each social role includes a set of norms, internal and external social expectations, and expected behaviors that may have an influence on individuals. According to transactional views, when individuals adapt a specific role, their experiences and behaviors may change, particularly when they are highly committed and show a high investment to the adult role (Roberts et al., 2005; Roberts & Wood, 2006). A cross-cultural investigation recently supported the assumption that becoming more agreeable and conscientious and less neurotic in early adulthood is largely the result of normative life transitions to adult social roles (Bleidorn et al., 2013). These results also indicated that cultures with an earlier onset of adult-role responsibilities were marked by earlier personality change in terms of maturity. In sum, the social investment theory claims that personality

development is the result of a dynamic interplay between individuals and adult roles.

Normative and Person-Specific Processes

Correlated change may reflect underlying *normative* developmental processes and thus refers to average change associations that seem to be true for the "average" population or studied sample. But it is likely that individuals differ in their development at every level, not just between persons of different ages, or between different persons of the same age, but also within a person over time. Consequently, *interindividual differences* in correlated change may exist, indicating that some individuals demonstrate correlated change whereas others do not or to a different degree. This idea is basically embodied in the concept of interindividual differences in intraindividual change (Nesselroade, 1991), which implies that some individuals change whereas others remain stable, and also individuals differ in degree and direction of change. The term "interindividual differences" emphasizes the differences among persons, whereas the term "intraindividual change" indicates variability within persons. In sum, it is important to take individual deviations from the normative change associations into account, as different individual causes and developmental mechanisms may underlie correlated change in personality.

Modeling Correlated Change

Simple Change Score Models

Previous work on correlated change used different modeling strategies to examine correlated change in personality. We briefly describe four strategies. A first modeling strategy refers to raw change (difference) scores as index of change. The change that is described in these models is change in *inter*individual differences. Change scores can be modeled either as directional or absolute (see Human et al., 2013, pp. 251-252). Simple change scores have recently regained popularity as an index of change when only two measurement occasions are available (e.g., Graham & Lachman, 2012; Human et al., 2013) because they are an easily

interpretable method. Correlated change reflects correlations between the raw (observed) change scores.

Cross-Lagged Panel Models

A second modeling strategy that is used in previous work on correlated change in personality refers to cross-lagged panel models with either manifest or latent factors (Bollen & Curran, 2006). The change that is described in these models is change in *inter*individual differences (cf. Selig & Little, 2012). In these models, correlated change—or more precisely, correlations between residuals—reflects the change association between two variables when their initial associations as well as their cross-lagged associations are controlled. Hence, estimates of correlated change are conditional on other parameters and indirect effects. They do not explicitly model change, but rather indirect manifestation of change (Hertzog & Nesselroade, 2003; see also Hamaker, Kuiper, & Grasman, 2015).

Latent Growth Curve Models and Multilevel Models

A third modeling strategy refers to latent growth curve models and multilevel models (Bollen & Curran, 2006; Meredith & Tisak, 1990; Preacher, Wichman, MacCallum, & Briggs, 2008). These models provide a better approach to modeling developmental change because they refer to *intra*individual change of a variable over time and *inter*individual differences in intraindividual change (cf. Hertzog & Nesselroade, 2003; see Wu, Selig, & Little, 2013 for an overview of both approaches). A typical minimal requirement is that there are at least three repeated measurements per individual. Another advantage of these models is that they can describe non-linear change in addition to linear change and they are capable of eliminating bias separating systematic changes from unsystematic sources of error[2]. Latent growth curve models and multilevel models are commonly used in the field of personality development (Graber et al., 2011; Jackson & Allemand, 2014; West, Ryu, Kwok, & Cham,

[2] It is important to note that in practical applications of growth curve models and multilevel models, it might be the case that non-linear change better fits the data. Modeling correlated change with complex growth patterns, however, represents a challenge in terms of interpretation of the results.

2011). To simultaneously assess different change processes and thus to examine correlated change, bivariate or multivariate latent growth curve models or multilevel models can be applied (Bollen & Curran, 2006). A multivariate latent growth curve models is a straightforward extension of the univariate latent curve model. Of interest is the correlation between the change parameters. Hence, correlated change is modeled on the latent level, which is uncontaminated by measurement error (see Hertzog, Lindenberger, Ghisletta, & Oertzen, 2006; Rast & Hofer, 2014 for longitudinal design considerations).

Latent Change Models

A final modeling strategy refers to latent change models (Ferrer & McArdle, 2010; McArdle, 2009; McArdle & Hamagami, 2001). As with latent growth curve models and multilevel models, latent change models focus on *intra*individual change and *inter*individual differences in intraindividual change (cf. Hertzog & Nesselroade, 2003). One important difference is that a single latent change model spans only a single longitudinal interval. Latent change models, along with latent growth curve models, belong to statistical models that separate systematic change from measurement error. These models are also common in the field of personality development (Jackson & Allemand, 2014). Correlated change can be investigated by correlating intraindividual longitudinal change scores among the variables of interest using bivariate or multivariate change models. A limitation of these models is that they are restricted to two measurement occasions and thus implicitly assume linear change between time points. However, these models can be extended to multiple latent change models across three or more time points (see McArdle & Nesselroade, 2014).

Current Status on Correlated Change

Big Five Personality Traits

In this section we discuss available empirical research with respect to the question of whether and to what degree changes in the Big Five personality traits are interrelated over time. To date, only a few studies have explicitly addressed the concept of correlated change

within the Big Five personality traits. Table 1 gives a summary of available studies. In the following, we briefly review and discuss the findings of these studies.

Allemand, Zimprich, and Hertzog (2007). This first study focused on cohorts of middle-aged individuals (N = 455, M_{age} = 43.7 years, SD = 0.90) and older adults (N = 420, M_{age} = 62.4 years, SD = 0.95) across two time points over a longitudinal interval of 4 years. Correlated change was modeled by means of multiple-group latent change models. In both cohorts, there was a considerable amount of commonality between changes in the personality traits (see Allemand et al., 2007, Table 4) with average absolute change correlations (Δrs) of .38 and .33 for middle-aged and older participants, respectively[3]. In particular, changes in neuroticism were strongly and negatively associated with changes in extraversion and conscientiousness, and changes in extraversion and conscientiousness were also strongly associated with each other. Although there were slightly different patterns of correlated change between middle-aged and older adults, the general picture has shown that personality change seems to occur in a concerted manner in both groups. Overall, these correlations among intraindividual change scores suggest that there is a certain degree of commonality in personality change in middle-aged and older adults.

Allemand, Zimprich, and Martin (2008). The older cohort was reassessed eight years later (N = 300), which allowed Allemand et al. to examine long-term correlated change in older adults across a 12-years longitudinal interval. The same latent change analyses were applied, as in Allemand et al (2007). Although a certain degree of commonality in long-term personality change was found, the patterns of correlated change showed a slightly different picture. Specifically, in contrast to the shorter time interval, the authors found that changes in neuroticism were no longer significantly associated with changes in the other Big Five traits, that is, a change in neuroticism did not co-occur with other traits over time and vice versa.

[3] First, the change correlations were converted to the Fisher's z metric. Second, the mean of the converted correlations was calculated and then converted back to the r metric.

However, changes in all other Big Five traits were substantially associated with one another (see Allemand et al., 2008, Table 3). Particularly the amount of correlated change of conscientiousness with extraversion and agreeableness was notable, with change coefficients (Δrs) larger than .60. The average absolute correlation (see Footnote 3 for the procedure) was .55 without neuroticism, and .38 including all five traits. The findings indicate that neuroticism did not simultaneously develop in tandem with the other traits in old age, whereas personality trait changes in the four remaining traits seem to occur in a concerted manner. The fact that the patterns of correlated change observed in the same cohort across 4 years did not replicate across 12 years might suggest that the time interval between measurement occasions play a moderating role. Furthermore, Allemand et al. (2008) tested for equality of the initial level factor and change factor correlations (*intercorrelations stationarity*) and found stationarity regarding initial and change associations except for neuroticism. Soto and John (2012) interpreted these results as reflecting initial level measurement overlaps between the personality traits that may largely explain the patterns of change observed, rather than previously independent traits changing in unison.

Lüdtke, Roberts, Trautwein, and Nagy (2011). This study examined personality development in students (N_{T1} = 4,544, M_{age} = 19.5 years, SD = 0.77) that were tracked from high school to university or to vocational training or work, with 3 assessments over 4 years. Although not the primary focus of the study, the results add findings on correlated change between personality traits. Latent growth curve models were applied to examine correlated change. A considerable amount of commonality between changes in the personality traits was found (see Lüdtke et al., 2011, Table 3), with an average absolute correlation (Δr; see Footnote 3 for the procedure) of .23. Change in neuroticism was negatively linked to change in extraversion, agreeableness, and conscientiousness, indicating that, on average, participants with above-average individual slope values in neuroticism tended to show below-average slope values in extraversion, agreeableness, and conscientiousness. In addition, change in

agreeableness was positively associated with change in extraversion and conscientiousness. Together, these correlations among intraindividual rates of change suggest that there is a certain degree of commonality in personality change among young adults.

Soto and John (2012). This study focused on very long-term correlated change between ages 21 and 61 in a small sample of 125 women who graduated from college in the 1960s, with 5 assessments over a longitudinal interval of 40 years. Correlated change was modeled using multilevel models. In contrast to the three previously discussed studies, no evidence for correlated change in the Big Five traits was found (see Soto & John, 2012, Table 5). The absolute magnitudes of these change correlations (Δrs) averaged only .09, and all were smaller than .20, and none were statistically significant. Soto and John (2012) additionally found that some pairs of facets tended to increase or decrease together. The general picture, however, indicates low commonality in personality changes over 40 years in women.

Mõttus, Johnson, Starr, and Deary (2012). This study examined personality development in old age between ages 81 to 87 ($N = 209$). The authors used latent growth curve models using two time points to examine correlated change. Several significant change correlations were found, but they were modest in size and generally similar to the level (baseline) correlations, albeit often slightly weaker. The absolute change correlations (Δrs) ranged from .02 to .30 (see Mõttus et al., 2012, Table 4), with an average correlation of .17 (see Footnote 3 for the procedure). None of the change correlations were significantly different from the corresponding level correlations, suggesting intercorrelations stationarity (cf. Allemand et al., 2008). The correlations among the personality trait changes may have merely reflected the conceptual and measurement overlaps between the traits (cf. Soto & John, 2012).

Klimstra, Bleidorn, Asendorpf, van Aken, and Denissen (2013). This paper reports the findings of two sets of studies on correlated change among the Big Five traits. The first

study used a large and representative sample (N = 14,886) that covers the ages from 17 to 96 years, with two assessments over 5 years. The sample was divided into 14 age cohorts with each cohort covering 4 years to test for the moderating role of age. Multiple-group manifest cross-lagged panel models were applied to model correlated change (i.e., residual correlations). Evidence for correlated change was found in all age groups (see Klimstra et al., 2013, Table 1). However, correlated change coefficients (Δrs) were generally rather modest and smaller than .15 at most ages across the lifespan (the average change correlation for the total sample was .13; the range between the age groups was .12 to .20). The general picture suggests that the overall degree of correlated change appeared to vary across the lifespan. That is, the amount of correlated change was relatively stable from adolescence through middle adulthood, but clearly increased in old age.

The second study focused on correlated change in adolescents (N = 174) from the ages 12 to 17 years. Again, correlated change was found across traits with an average change correlation of .25 (see Klimstra et al., 2013, Table 2). However, changes in conscientiousness were not associated with changes in agreeableness and extraversion. Taken the results of the two studies together, the reported change correlations (i.e., residual correlations) suggest that there is a certain degree of commonality in personality change at most ages across the lifespan. Moreover, these results show a tendency toward an increase in the amount of correlated change in old age.

Mund and Neyer (in press). This study examined personality development in young adults (N_{T1} = 654, M_{age} = 24.4 years, SD = 3.69) that were assessed at two measurement occasions over 15 years. Although not the primary focus of the study, the results add findings on correlated change between personality traits. Multivariate latent change models were applied. The absolute change correlations (Δrs; see Mund & Neyer, in press, Table 2) ranged from .05 to .65, with an average correlation of .30 (see Footnote 3 for the procedure).

Together, these correlations among intraindividual rates of change suggest that there is a certain degree of commonality in personality change among young adults.

Tentative Conclusions

Several conclusions can be made from this brief review of available studies on correlated change among the Big Five traits. First, previous studies, except for one study, found consistent evidence for the existence of significant *within-domain* correlated change in personality. This suggests that changes in personality traits demonstrate a certain degree of commonality. Second, the degree of correlated change associations were—with some exceptions—rather modest, with effect sizes ranging from small to medium-sized effects (Cohen, 1988). The average absolute change correlation (Δr) across all average coefficients in Table 1 is .25. Broadly speaking, this implies that specific, narrowly acting mechanisms may have more impact on personality change in specific traits than general and broadly acting mechanisms. This change correlation could also depend on regularity and stability of environmental conditions. If environmental conditions would vary completely randomly and completely unpredictably, then we might expect a zero correlation. So the .25 may also be something like an environmental predictability indicator. Alternatively, we may consider that even in rapidly changing environments we are not changing the self-description of our traits immediately with each change. In this case, the remaining .75 would be an indicator of stabilizing our personality no matter what changes the environment suggests, and .25 is the portion responding to the environmental changes[4]. Then it is an open question if that ratio will remain the same no matter how much the environment changes. Third, the patterns of change correlations did not show a systematic and consistent picture across the studies. Specifically, the two theoretically derived patterns of correlated change—one that refers to pronounced changes among agreeableness, conscientiousness, and (low) neuroticism, and the other that

[4] Squaring the average change correlation to express explained variance ($.25^2 = .0625$) would result in a lot more unexplained variance (i.e., .9375) (but see Johnson, 2011).

refers to pronounced changes among extraversion and openness for experience were not consistently found across studies[5]. Fourth, it seems that in addition to specific, narrowly acting mechanisms affecting single traits in unique ways, there also seem to be general, broadly acting mechanisms that simultaneously affecting change in multiple traits. The general picture suggests that the Big Five personality traits work together as a dynamic, integrated system, notably in the case of personality change (cf. Robins & Tracy, 2003).

The current status on correlated change in personality suggests that a certain degree in commonality in change between the Big Five traits does exit. However, it is important to note that the available empirical evidence for correlated change is limited to date. Moreover, existing studies differed from each other in several ways. First, the *sample composition* and the targeted *age groups* (i.e., distinct age groups versus lifespan samples with continuous age range) were different. It is possible that age moderates the associations between changes among the traits, as suggested by Klimstra et al.'s (2013) findings. Second, the *sample sizes* of the reported studies differed considerably. The required sample size and power to detect correlated change is an important issue with respect to the longitudinal designs (cf. Hertzog et al., 2006; Rast & Hofer, 2014). Third, the *time intervals* between the assessments ranged from 4 years to 40 years between the studies. It is possible then that the change associations among the traits vary as a function of time. Fourth, the *statistical approaches* to modeling correlated change varied across the studies. Likewise, while some studies modeled personality traits as latent factors, others modeled the traits as manifest factors. One advantage of modeling change on the latent level is that change is estimated uncontaminated by measurement error. It is possible then that the degree of correlated change vary as a function of latent versus manifest modeling of the constructs or as a function of the utilized statistical approaches.

Big Five Personality Traits and Other Domains

[5] It is important to note that a two-factor model of correlated change was not formally tested in these studies. Future research may use the summary data as a starting point for post-hoc analyses of the factor structure of correlated change.

A burgeoning group of studies have addressed the concept of correlated change *between* the Big Five personality traits and a variety of domains such as health and work. For illustrative purposes, we discuss selected studies with respect to correlated change between the Big Five personality traits and indicators of the three broad life domains of health, social relationships, work and education.

Health and well-being. Health is an important life domain in adulthood that may become particularly important as individuals move toward old age. There is a large literature on the links between personality, well-being, and health from a lifespan perspective (see Friedman & Kern, 2014 for a review). However, the question of whether and to what degree personality traits change in concert with health is underrepresented in the literature on personality development.

Available studies have examined change associations with respect to self-reported subjective health (Letzring, Edmonds, & Hampson, 2014; Mund & Neyer, in press; Small et al., 2003), health-related behaviors (Takahashi, Edmonds, Jackson, & Roberts, 2013), subjective well-being (Specht, Egloff, & Schmukle, 2013; Soto, 2015; Watson & Humrichouse, 2006), and depression (Chow & Roberts, 2014). One of the first studies examined change associations between the Big Five traits and self-reported health in adults aged 55 to 85 years over 6 years (Small et al., 2003). The findings, however, do not support the claim of correlated change between personality traits and self-reported health (but see Letzring et al., 2014). The second example refers to correlated change in adults' aged 19 to 94 years over 3 years (Takahashi et al., 2013). In addition to the assessment of conscientiousness and self-perceived physical health, a variety of health behaviors and preventative health-related behaviors were assessed. The results indicated that changes in conscientiousness were significantly and positively correlated with changes in preventative health behaviors and changes in self-perceived physical health. Moreover, changes in preventative health behaviors partially mediated the relation between changes in conscientiousness and changes in self-

perceived physical health. In sum, previous work suggests a certain degree of commonality in change between personality and health.

Social relationships. Family and friends and, more generally, the broader social network including diverse social relationships, represent important developmental contexts or realms of experiences in adulthood (e.g., Schaffhuser et al., 2014). Relationships experiences and social roles that are centered within family, friendships, and other relationships may influence the individual and promote or prevent individual changes. At the same time, it is possible that individual characteristics may have an influence on relationship experiences in diverse social relationships. According to the social investment theory (Roberts et al., 2005), as role investment and quality increases, individuals should exhibit increases in the corresponding traits that the role promotes. This transactional view would assume correlated change between personality traits and indicators of social relationships and functioning.

Several studies tested correlated change between personality traits and relationship variables such as relationship satisfaction (Scollon & Diener, 2006), relationship fluctuation (Zimmermann & Neyer, 2013), social network characteristics (Neyer & Lehnart, 2007; Parker, Lüdtke, Trautwein, & Roberts, 2012), loneliness (Mund & Neyer, in press), social well-being (Hill, Turiano, Mroczek, & Roberts, 2012), social engagement (Lodi-Smith & Roberts, 2012) and social support (Allemand, Schaffhuser, & Martin, 2015). For example, a study of adults aged 16 to 70 years evidenced long-term correlated changes between extraversion and neuroticism, respectively, and relationship satisfaction over 8 years (Scollon & Diener, 2006). While increases in neuroticism significantly corresponded to decreases in relationship satisfaction, increases in extraversion were only marginally related to increases in relationship satisfaction. The second example refers to long-term personality-social support associations (Allemand et al., 2015). The findings indicated that concurrent personality-social support associations also hold longitudinally over 8 years, reflecting the fact that individual change in personality traits were accompanied by a tendency of proportional individual

changes in perceptions of social support (see also Hill, Payne, Jackson, Stine-Morrow, & Roberts, 2013).

Previous studies on between-domain correlated change typically used the same method to assess changes in personality and social experiences (*within-method*). A notable exception is Watson and Humrichouse (2006) who examined the convergence across different change assessments. More specifically, they compared self- and spouse-ratings using simple raw change scores. They obtained significant convergent change correlations (*between-method*) only for conscientiousness and neuroticism in a young adult newlywed sample across a 2-year time interval. The coefficients were consistently low and revealed little convergence between change assessments across two different rating methods. However, several studies do exist that examined personality traits longitudinally using different methods, though, not with a focus on correlated change. For example, a longitudinal study examined personality change across adolescence and middle adulthood in families (Branje, Van Lieshout, & Gerris, 2007). The study design included three annual self- and other-reports of personality traits of two target adolescents and their parents per family. Although Branje et al. (2007) did not formally studied between-method correlated change; this design could be easily used to study correlated change using two different methods. In sum, the broad picture from previous work indicates that personality changes are associated with changes in social experiences, as the change assessments referred to the same method.

Work and education. The workplace is one of the primary settings in adulthood, and individuals' identities are largely defined by their work. The work context does not reflect a consistent and stable environment but rather a changing world. Education is a particularly important developmental context in the transition from adolescence to early adulthood. Occupational and educational experiences may influence the individual and promote or prevent individual changes. At the same time, it is possible that individual characteristics may have an influence on work and education experiences as well.

Only a handful studies have examined whether and to what degree personality traits change in concert with work-related variables, such as work satisfaction (Scollon & Diener, 2006), organizational citizenship behaviors (Hudson, Roberts, & Lodi-Smith, 2012), and work attitudes (Wille, Hofmans, Feys, & De Fruyt, 2014). For example, Wille et al. (2014) examined correlated change between employees' attitudes and personality traits across 15 years. The results demonstrated substantial long-term correlated change between traits and attitudes, particularly with respect to job satisfaction. For example, increases in job satisfaction were linked with decreases in neuroticism and increases in extraversion and conscientiousness. More important, the patterns of correlated change between traits and attitudes largely mirrored the patterns of the initial level associations and that signals a maturational process and/or reflects measurement overlaps (cf. Soto & John, 2012). The second example refers to the context of education. Bleidorn (2012) investigated the role of achievement behavior for short-term personality development in the transition from high school to adult life in a sample of students. The results revealed significant change correlations particularly with neuroticism, openness, and conscientiousness. More specifically, those students who increased in their investment into achievement showed greater decreases in neuroticism and increases in openness and conscientiousness. In sum, the discussed examples suggest associated changes between the two domains of personality and work/education.

Tentative Conclusions

Previous studies have shown not only that personality traits change, but they do in concert with experiences in several life domains. In other words, changes in personality were consistently related to changes in health, social relationships, work and education. The results of *between-domain* correlated change provide empirical support for transactional perspectives that highlight the development of the individual or couple in relation to contextual, environmental, sociocultural influences and changes across the lifespan (e.g., Caspi &

Roberts, 2001; Fraley & Roberts, 2005; Roberts et al., 2008). However, it is important to note that the current picture is blurred by the fact that the available studies differ from each other in many respects including constructs, sample composition, sample size, time intervals, or statistical approaches. This makes comparative efforts challenging.

Challenges and Future Directions

Although the field of personality development is steadily growing, the concept of correlated change remains largely underexplored, in particularly with respect to within-domain correlated change among the Big Five traits. The main goal of this paper thus was to provide sound theoretical and empirical arguments for the relevance of correlated change as an important complimentary perspective of change and stability. In the following, we discuss several future directions.

Conceptual/Theoretical Implications

The concept of correlated change has great potential to inform theory development, as it is essential to a better understanding of underlying mechanisms that potentially shape developmental processes over longer time periods and short-term dynamic processes in daily life (cf. Hertzog & Nesselroade, 2003). The proposed categorization framework for correlated change emphasizes the importance of taking at least the dimensions of time, person, domain, and method into account. As psychologists, we are trying to understand how individuals in interaction with their within-person abilities, characteristics, and activities and their environmental contexts manage to maintain their identity, well-being, or autonomy across the lifespan. Therefore, at the core of a psychological research program we need to understand how correlated changes over time, within and between persons, within and between domains, and within and across domains and contexts are related when resulting in the maintenance of identity, well-being, or autonomy across the lifespan. The current state of the correlated change research on personality allows us now to go one step further in this direction. Once we combine frequent real life observation data from multiple interacting persons, about multiple

activities, emotions or cognitions in multiple domains, it principally allows enough measurements to generate sufficient statistical power to test complex within-person across-domain across-situation across-interaction-partners correlated change models. Then, the correlated change approach will lead to a rapid increase in our understanding of short-term dynamics and their relations to long-term developmental changes. What is more, we can also apply an additional theoretical approach from functional psychology (Martin, Jäncke & Röcke, 2012; Martin, Schneider, Eicher, & Moor, 2012; see also Wood & Denissen, 2015; Wood et al., 2015 for other functional and process approaches to behavior). That is, we can ask which correlated changes and which changes in their direction, duration or strength can produce the stabilization of personality. One could think about it like a downhill slalom ski race. If we consider the distance from start to finish as the lifespan, we can now observe dynamic changes in the temporary correlated change of upper and lower body movements and many other factors. These dynamic changes in correlated change are what allow the stabilization of a trait of conscientiousness ("always give your best") and goal achievement given a variable and partly unpredictable environment (due to earlier riders, weather and light conditions). Focusing on the stabilization of a higher-order variable such as the trait of conscientiousness provides a different interpretation framework to understand and explain correlated changes. Applied to correlated changes in personality, we may start theorizing about how correlated changes in personality trait activations are related to identity formation and stabilization (e.g., Hill et al., 2013).

Research Implications

The concept of correlated change and the proposed categorization framework has great potential to inform and to inspire future research in the field of personality development. One potential avenue for future research is to further acummulate evidence about the pattern and degree of change correlations among and between the Big Five personality traits and other constructs in terms of a *"nomological correlated change network"*. This idea is based on

Cronbach and Meehl's (1955) view of construct validity. In order to provide evidence that a measure has construct validity, a nomological network has to be developed for its measure. To accumulate empirical work on correlated change in personality, it is important for future research to use multiple methods of change assessment, such as observer ratings and partner-reports, behavioral experiments, and daily life paradigms to eliminate the shared variance from self-reports. The study of between-method correlated change is important to examine the convergence across different change assessments (cf. Watson & Humrichouse, 2006). As another avenue for future research is to use measurement-burst designs with the unique opportunity to study correlated change in personality-related processes that transpire over very different temporal intervals (cf. Sliwinski, 2008). For example, it would be interesting to link short-term change or variability in daily or momentary state manifestations of personality (i.e., feelings, thoughts, and behaviors) with long-term personality development. If short-term change in daily or momentary manifestations of personality were systematically related to long-term personality trait change, this would have practical implications for intervention efforts. In addition to examine the presence of correlated change within and between the Big Five traits and other psychological mechanisms and the degree of these, it is also important to examine why and how correlated change comes about. Hence, an important avenue for future research is to identify the underlying mechanisms of correlated change as well as the predictors and outcomes of correlated change in personality. It is also important to consider the possibility that a third variable may affect the variables at the same time. In addition to meaningful causes, less meaningful source of systematic transient error may inflate estimates of correlated change. Hence, future research should identify third variables that affect correlated change. Similarly, future studies may examine potential moderators of correlated change such as demographic variables (e.g., age groups; Allemand et al., 2007; Klimstra et al., 2013) or psychological variables (e.g., cognitive abilities; Klimstra et al., 2013). Finally, a potential avenue for future research is to advance the statistical modeling of correlated change

in order to determine the adequate modeling strategies and techniques. Moreover, future research should include state of art longitudinal analysis methods and also recent methodological developments (e.g., Bishop, Geiser, & Cole, 2015; Grimm, An, McArdle, Zonderman, & Resnick, 2012; Wu et al., 2013).

Practical Implications

Finally, the concept of correlated change has also great potential to inform future intervention and prevention programs aimed at self-improvement and volitional personality change (Hudson & Fraley, in press). For example, knowing that (a) short-term and long-term personality changes are interrelated or that (b) decreases or increases in personality traits over time are associated with changes in individual and social functioning (e.g., relationship and work satisfaction) might be informative for intervention efforts for individuals and couples, as well as career and developmental counseling, coaching, and mentoring. Furthermore, knowing (c) what factors are associated with changes in personality traits is vital to enhancing physical health and subjective well-being. The correlated change approach suggests that changes in one variable may be causing changes in another. This causality assumption can be tested through interventions targeting one or the other variable. However, it is also possible that the longer-term correlation between changes is caused by a dynamic interplay of changes in both variables. Here we first need a specific theoretical model as to exactly define how and when this interplay should lead to advantageous outcomes before designing and testing the intervention. Ultimately, the correlated change approach assumes that multiple levels within and across persons and multiple contexts covary in systematic ways to produce positive developmental outcomes. This suggests considering interventions that target the individual management of these various changes to achieve desired outcomes. Once we understand better which correlated changes can produce desired outcomes equally well, we can add correlated change management interventions to interventions aiming at the improvement of single factors to our repertoire of developmental interventions.

Conclusion

Correlated change is a unique and complementary perspective to understanding the patterns, causes, and mechanisms of personality development. While the classical multiple perspectives to evaluate change and stability have provided several important insights, the field of personality development remains wide open for future investigations on long-term and short-term correlated change within and between persons and across a variety of domains and methods. In this article, we proposed a categorization framework that emphasizes the importance of at least four important dimensions of correlated change. We hope that this framework and the discussed theoretical accounts and statistical modeling approaches may stimulate future conceptual/theoretical advances and empirical work on correlated change in personality.

References

Allemand, M., Schaffhuser, K., & Martin, M. (2015). Long-term correlated change between personality traits and perceived social support in middle adulthood. *Personality and Social Psychology Bulletin*, *41*, 420-432.

Allemand, M., Zimprich, D., & Hertzog, C. (2007). Cross-sectional age differences and longitudinal age changes of personality in middle adulthood and old age. *Journal of Personality*, *75*, 323-358.

Allemand, M., Zimprich, D., & Martin, M. (2008). Long-term correlated change in personality traits in old age. *Psychology and Aging*, *23*, 545-557.

Asendorpf, J. B., & van Aken, M. A. (1999). Resilient, overcontrolled, and undercontroleed personality prototypes in childhood: Replicability, predictive power, and the trait-type issue. *Journal of Personality and Social Psychology*, *77*, 815-832.

Baltes, P. B., & Lindenberger, U. (1997). Emergence of a powerful connection between sensory and cognitive functions across the adult life span: A new window to the study of cognitive aging? *Psychology and Aging*, *12*, 12-21.

Biesanz, J. C., West, S. G., & Kwok, O. M. (2003). Personality over time: Methodological approaches to the study of short-term and long-term development and change. *Journal of Personality*, *71*, 905-942.

Bishop, J., Geiser, C., & Cole, D. A. (2015). Modeling latent growth with multiple indicators: A comparison of three approaches. *Psychological Methods, 20,* 43-62.

Bleidorn, W. (2012). Hitting the road to adulthood: Short-term personality development during a major life transition. *Personality and Social Psychology Bulletin*, *38*, 1594–1608.

Bleidorn, W., Klimstra, T. A., Denissen, J. J., Rentfrow, P. J., Potter, J., & Gosling, S. D. (2013). Personality maturation around the world: A cross-cultural examination of social-investment theory. *Psychological Science, 24*, 2530-2540.

Bollen, K. A., & Curran, P. J. (2006). *Latent curve models: A structural equation perspective*. Hoboken, NJ: John Wiley & Sons.

Butler, E. A., & Randall, A. K. (2013). Emotional coregulation in close relationships. *Emotion Review,* 5, 202-210.

Caspi, A., & Roberts, B. W. (2001). Personality development across the life course: The argument for change and continuity. *Psychological Inquiry*, *12*, 49-66.

Chow, P. I., & Roberts, B. W. (2014). Examining the relationship between changes in personality and changes in depression. *Journal of Research in Personality*, 51, 38-46.

Cohen, J. (1988*). Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.

Costa, P. T. Jr., & McCrae, R. R. (1992). *Professional manual: Revised NEO Personality Inventory (NEO-PI-R) and NEO Five-Factor Inventory (NEO-FFI).* Odessa, FL: Psychological Assessment Resources.

Cronbach, L. J., & Meehl, P. E. (1955). Construct validity in psychological tests. *Psychological Bulletin*, *52*, 281.

DeYoung, C. G., & Gray, J. R. (2009). Personality neuroscience: Explaining individual differences in affect, behavior, and cognition. In P. J. Corr & G. Matthews (Eds.), *The Cambridge handbook of personality psychology* (pp. 323–346). New York: Cambridge University Press.

DeYoung, C. G., Peterson, J. B., & Higgins, D. M. (2002). Higher-order factors of the Big Five predict conformity: Are there neuroses of health? *Personality and Individual Differences*, *33*, 533-552.

Digman, J. M. (1997). Higher-order factors of the Big Five. *Journal of Personality and Social Psychology*, *73*, 1246-1256.

Ferrer, E., & McArdle, J. J. (2010). Longitudinal modeling of developmental changes in psychological research. *Current Directions in Psychological Science*, *19*, 149-154.

Fleeson, W. (2007). Studying personality processes: Explaining change in between-persons longitudinal and within-person multilevel models. In R. W. Robins, R. C. Fraley, & R. F. Krueger (Eds.), *Handbook of research methods in personality psychology* (pp. 523-542). New York: Guilford.

Fraley, R. C., & Roberts, B. W. (2005). Patterns of continuity: A dynamic model for conceptualizing the stability of individual differences in psychological constructs across the life course. *Psychological Review, 112*, 60-74.

Friedman, H. S., & Kern, M. L. (2014). Personality, well-being, and health. *Annual Review of Psychology*, *65*, 719-742.

Gerlitz, J.-Y., & Schupp, J. (2005). Zur Erhebung der Big-Five-basierten Persönlichkeitsmerkmale im SOEP. *Research Notes, 4*, 1-36.

Goldberg, L. R. (1999). A broad-bandwidth, public domain, personality inventory measuring the lower-level facets of several five-factor models. In I. Mervielde, I. Deary, F. De Fruyt, & F. Ostendorf (Eds.), *Personality psychology in Europe*, Vol. 7 (pp. 7-28). Tilburg, The Netherlands: Tilburg University Press.

Gough, H. G., & Bradley, P. (1996). *CPI manual* (3rd ed.). Palo Alto, CA: Consulting Psychologists Press.

Graber, E. C., Laurenceau, J-P, & Carver, C. (2011). Integrating the dynamics of personality and close relationship processes: Methodological and data analytic implications. *Journal of Personality*, 79, 1101-1137.

Graham, E. K., & Lachman, M. E. (2012). Personality stability is associated with better cognitive performance in adulthood: Are the stable more able? *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *67*, 545-554.

Grimm, K. J., An, Y, McArdle, J. J., Zonderman, A. B., & Resnick, S. M. (2012). Recent changes leading to subsequent changes: Extensions of multivariate latent difference score models. *Structural Equation Modeling: A Multidisciplinary Journal*, *19*, 268-292.

Hamaker, E. L., Kuiper, R. M., & Grasman, R. P. P. P. (2015). A critique of the cross-lagged panel model. *Psychological Methods, 20,* 102-116.

Hertzog, C., Lindenberger, U., Ghisletta, P., & Oertzen, T. V. (2006). On the power of multivariate latent growth curve models to detect correlated change. *Psychological Methods*, *11*, 244-252.

Hertzog, C., & Nesselroade, J. R. (2003). Assessing psychological change in adulthood: an overview of methodological issues. *Psychology and Aging*, *18*, 639-657.

Hill, P. L., Allemand, M., Zehnder Grob, S., Peng, A., Morgenthaler, C., & Käppler, C. (2013). Longitudinal relations between personality traits and aspects of identity formation during adolescence. *Journal of Adolescence, 36*, 413-421.

Hill, P. L., Turiano, N. A., Mroczek, D. K., & Roberts, B. W. (2012). Examining concurrent and longitudinal relations between personality traits and social well-being in adulthood. *Social Psychological and Personality Science*, *3*, 698-705.

Hill, P. L., Payne, B. R., Jackson, J. J., Stine-Morrow, E. A., & Roberts, B. W. (2014). Perceived social support predicts increased conscientiousness during older adulthood. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *69*, 543-547.

Hofer, S. M., Flaherty, B. P., & Hoffman, L. (2006). Cross-sectional analysis of time-dependent data: Mean-induced association in age-heterogeneous samples and an alternative method based on sequential narrow age-cohort samples. *Multivariate Behavioral Research*, *41*, 165-187.

Hudson, N. W., & Fraley, R. C. (in press). Volitional personality trait change: Can people choose to change their personality traits? *Journal of Personality and Social Psychology*.

Hudson, N. W., Fraley, R. C., Brumbaugh, C. C., & Vicary, A. M. (2014). Coregulation in romantic partners' attachment styles: A longitudinal investigation. *Personality and Social Psychology Bulletin*, *40*, 845-857.

Hudson, N. W., Roberts, B. W., & Lodi-Smith, J. (2012). Personality trait development and social investment in work. *Journal of Research in Personality*, *46*, 334-344.

Human, L. J., Biesanz, J. C., Miller, G. E., Chen, E., Lachman, M. E., & Seeman, T. E. (2013). Is change bad? Personality change is associated with poorer psychological health and greater metabolic syndrome in midlife. *Journal of Personality, 81*, 249-260.

Jackson, J. J., & Allemand, M. (2014). Moving personality development research forward: Applications using structural equation models. *European Journal of Personality*, *28*, 300-310.

Johnson, W. (2011). Correlation and explaining variance: To square or not to square? *Intelligence, 37*, 249-254.

Kandler, C., Kornadt, A. E., Hagemeyer, B., & Neyer, F.-J. (in press). Patterns and sources of personality development in old age. *Journal of Personality and Social Psychology.*

Kelly, G. A. (1955). *The psychology of personal constructs*. Vol. I, II. New York: Norton.

Klimstra, T. A., Bleidorn, W., Asendorpf, J. B., Van Aken, M. A., & Denissen, J. J. (2013). Correlated change of Big Five personality traits across the lifespan: A search for determinants. *Journal of Research in Personality*, *47*, 768-777.

Letzring, T. D., Edmonds, G. W., & Hampson, S. E. (2014). Personality change at mid-life is associated with changes in self-rated health: Evidence from the Hawaii Personality and Health Cohort. *Personality and Individual Differences*, *58*, 60-64.

Lodi-Smith, J., & Roberts, B. W. (2007). Social investment and personality: A meta-analysis of the relationship of personality traits to investment in work, family, religion, and volunteerism. *Personality and Social Psychology Review*, *11*, 68-86.

Lodi-Smith, J., & Roberts, B. W. (2012). Concurrent and prospective relationships between social engagement and personality traits in older adulthood. *Psychology and Aging*, *27*, 720-727.

Lucas, R. E., & Donnellan, M. B. (2011). Personality development across the life span: Longitudinal analyses with a national sample from Germany. *Journal of Personality and Social Psychology*, *101*, 847-861.

Lüdtke, O., Roberts, B. W., Trautwein, U., & Nagy, G. (2011). A random walk down university avenue: life paths, life events, and personality trait change at the transition to university life. *Journal of Personality and Social Psychology*, *101*, 620-637.

Marsh, H. W., Nagengast, B., & Morin, A. J. S. (2013). Measurement invariance of Big-Five factors over the life span: ESEM tests of gender, age, plasticity, maturity, and La Dolce Vita effects. *Developmental Psychology, 49*, 1194-1218.

Martin, M., Jäncke, L., & Röcke, C. (2012). Functional approaches to lifespan development: Towards aging research as the science of stabilization. *Journal of Gerontopsychology and Geriatric Psychiatry, 25*, 185-188.

Martin, M., Schneider, R., Eicher, S., & Moor, C. (2012). The functional Quality of Life (*f*QOL) model: A new basis for Quality of life-enhancing interventions in old age. *Journal of Gerontopsychology and Geriatric Psychiatry, 25*, 33-40.

Martin, M., & Zimprich, D. (2003). Are changes in cognitive functioning in older adults related to changes in subjective complaints? *Experimental Aging Research*, *29*, 335-352.

Mascherek, A., & Zimprich, D. (2011). Correlated change in memory complaints and memory performance across 12 years. *Psychology and Aging*, *26*, 884-889.

McArdle, J. J. (2009). Latent variable modeling of differences and changes with longitudinal data. *Annual Review of Psychology*, *60*, 577-605.

McArdle, J. J., & Hamagami, F. (2001). Latent difference score structural models for linear dynamic analyses with incomplete longitudinal data. In L. M. Collins & A. G. Sayer (Eds.), *New methods for the analysis of change* (pp. 139-175). Washington, DC, US: American Psychological Association.

McArdle, J. J., & Nesselroade, J. R. (1994). Using multivariate data to structure developmental change. In H. W. Reese & S. H. Cohen (Eds.), *Lifespan developmental psychology: Methodological contributions* (pp. 223-267). Hillsdale, NJ: Lawrence Erlbaum.

McArdle, J. J., & Nesselroade, J. R. (2014). *Longitudinal data analysis using structural equation models*. Washington, DC: American Psychological Association.

Meredith, W., & Tisak, J. (1990). Latent curve analysis. *Psychometrika*, *55*, 107-122.

Mõttus, R., Johnson, W., Starr, J. M., & Deary, I. J. (2012). Correlates of personality trait levels and their changes in very old age: The Lothian birth cohort 1921. *Journal of Research in Personality*, *46*, 271-278.

Mroczek, D. K., & Spiro, A. (2003). Modeling intraindividual change in personality traits: Findings from the Normative Aging Study. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *58*, 153-165.

Mund, M., & Neyer, F. J. (in press). The winding paths of the lonesome cowboy: Evidence for mutual influences between personality, subjective health, and loneliness. *Journal of Personality.*

Nesselroade, J. R. (1991). Interindividual differences in intraindividual change. In L. M. Collins & J. L. Horn (Eds.), *Best methods for the analysis of change: Recent advances, unanswered questions, future directions* (pp. 92-105). Washington, DC: American Psychological Association.

Neyer, F. J. & Lehnart, J. (2007). Relationships matter in personality development. Evidence from an 8-year longitudinal study across young adulthood. *Journal of Personality, 75*, 535-568.

Neyer, F. J., Mund, M., Zimmermann, J., & Wrzus, C. (2014). Personality-relationship transactions revisited. *Journal of Personality, 82*, 539-550.

Nye, C. D., Allemand, M., Gosling, S. D., Potter, J., & Roberts, B. W. (in press). Personality trait differences between young and middle-aged adults: Measurement artifacts or actual trends? *Journal of Personality*.

Parker, P. D., Lüdtke, O., Trautwein, U., & Roberts, B. W. (2012). Personality and relationship quality during the transition from high school to early adulthood. *Journal of Personality*, *80*, 1061-1089.

Preacher, K. J., Wichman, A. L., MacCallum, R. C., & Briggs, N. E. (2008). *Latent growth curve modeling.* Thousand Oaks, CA: Sage.

Rast, P., & Hofer, S. M. (2014). Longitudinal design considerations to optimize power to detect variances and covariances among rates of change: Simulation results based on actual longitudinal studies. *Psychological Methods*, *19*, 133-154.

Roberts, B. W., & DelVecchio, W. F. (2000). The rank-order consistency of personality traits from childhood to old age: A quantitative review of longitudinal studies. *Psychological Bulletin*, *126*, 3-25.

Roberts, B. W., & Mroczek, D. (2008). Personality trait change in adulthood. *Current Directions in Psychological Science*, *17*, 31-35.

Roberts, B. W., Walton, K. E., & Viechtbauer, W. (2006). Patterns of mean-level change in personality traits across the life course: A meta-analysis of longitudinal studies. *Psychological Bulletin, 132*, 1-25.

Roberts, B. W., & Wood, D. (2006). Personality development in the context of the neosocioanalytic model of personality. In D. K. Mroczek & T. D. Little (Eds.), *Handbook of personality development* (pp. 11-39). Mahwah, NJ: Erlbaum.

Roberts, B. W., Wood, D., & Caspi, A. (2008). The development of personality traits in adulthood. In O. P. John, R.W. Robins, & L. A. Pervin (Eds.), *Handbook of personality: Theory and research* (3rd ed., pp. 375-398). New York: Guilford.

Roberts, B. W., Wood, D., & Smith, J. L. (2005). Evaluating five factor theory and social investment perspectives on personality trait development. *Journal of Research in Personality*, *39*, 166-184.

Robins, R. W., & Tracy, J. L. (2003). Setting an agenda for a person-centered approach to personality development. *Monographs of the Society for Research in Child Development*, *68*, 110-122.

Salthouse, T. A. (1996). The processing-speed theory of adult age differences in cognition. *Psychological review*, *103*, 403-428.

Schaffhuser, K., Allemand, M., & Martin, M. (2014). Personality traits and relationship satisfaction in intimate couples: Three perspectives on personality. *European Journal of Personality*, *28*, 120-133.

Scollon, C. N., & Diener, E. (2006). Love, work, and changes in extraversion and neuroticism over time. *Journal of Personality and Social Psychology*, *91*, 1152-1165.

Selig, J. P., & Little, T. D. (2012). Autoregressive and cross-lagged panel analysis for longitudinal data. In B. Laursen, T. D. Little & N. E. Card (Eds.), *Handbook of developmental research methods* (pp. 265–278). New York: Guilford Press.

Small, B. J., Hertzog, C., Hultsch, D. F., & Dixon, R. A. (2003). Stability and change in adult personality over 6 years: Findings from the Victoria Longitudinal Study. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *58*, 166-176.

Sliwinski, M. J. (2008). Measurement-burst designs for social health research. *Social and Personality Psychology Compass, 2*, 245-261.

Sliwinski, M. J., Hofer, S. M., & Hall, C. (2003). Correlated and coupled cognitive change in older adults with and without preclinical dementia. *Psychology and Aging*, *18*, 672-683.

Soto, C. J. (2015). Is happiness good for your personality? Concurrent and prospective relations of the Big Five with subjective well-being. *Journal of Personality*, *83*, 45-55.

Soto, C. J., & John, O. P. (2012). Development of Big Five domains and facets in adulthood: Mean-level age trends and broadly versus narrowly acting mechanisms. *Journal of Personality*, *80*, 881-914.

Soto, C. J., John, O. P., Gosling, S. D., & Potter, J. (2011). Age differences in personality traits from 10 to 65: Big Five domains and facets in a large cross-sectional sample. *Journal of Personality and Social Psychology*, *100*, 330-348.

Specht, J., Egloff, B., & Schmukle, S. C. (2011). Stability and change of personality across the life course: The impact of age and major life events on mean-level and rank-order stability of the Big Five. *Journal of Personality and Social Psychology*, *101*, 862-882.

Specht, J., Egloff, B., & Schmukle, S. C. (2013). Examining mechanisms of personality maturation: The impact of life satisfaction on the development of the Big Five personality traits. *Social Psychological and Personality Science, 4*, 181-189.

Staudinger, U. M., & Kunzmann, U. (2005). Positive adult personality development: Adjustment and/or growth? *European Psychologist*, *10*, 320-329.

Takahashi, Y., Edmonds, G. W., Jackson, J. J., & Roberts, B. W. (2013). Longitudinal correlated changes in conscientiousness, preventative health-related behaviors, and self-perceived physical health. *Journal of Personality*, *81*, 417-427.

Terracciano, A., Costa, P. T., & McCrae, R. R. (2006). Personality plasticity after age 30. *Personality and Social Psychology Bulletin*, *32*, 999-1009.

Walker, B. M., & Winter, D. A. (2007). The elaboration of personal construct psychology. *Annual Review of Psychology*, *58*, 453-477.

Watson, D., & Humrichouse, J. (2006). Personality development in emerging adulthood: Integrating evidence from self-ratings and spouse ratings. *Journal of Personality and Social Psychology*, *91*, 959-974.

West, S. G., Ryu, E., Kwok, O. M., & Cham, H. (2011). Multilevel modeling: Current and future applications in personality research. *Journal of Personality*, *79*, 2-50.

Wille, B., Hofmans, J., Feys, M., & De Fruyt, F. (2014). Maturation of work attitudes: Correlated change with Big Five personality traits and reciprocal effects over 15 years. *Journal of Organizational Behavior*, *35*, 507-529.

Wood, D., & Denissen, J. J. A. (2015). A functional perspective on personality trait development. In N. R. Branscombe & K. Reynolds (Eds.), *Psychology of change: Life contexts, experiences, and identities* (pp. 97-115). New York: Psychology Press.

Wood, D., Hensler Gardner, M., & Harms, P. D. (2015). How functionalist and process approaches to behavior can explain trait covariation. *Psychological Review, 122*, 84-111.

Wu, W., Selig, J. P., & Little, T. D. (2013). Longitudinal data analyses. In T. D. Little (Ed.), *Oxford handbook of quantitative methods: Volume 2* (pp. 387-410). New York, NY: Oxford University Press.

Zimmermann, J., & Neyer, F. J. (2013). Do we become a different person when hitting the road? Personality development of sojourners. *Journal of Personality and Social Psychology, 105*, 515-530.

Zimprich, D., Allemand, M., & Lachman, M. E. (2012). Factorial structure and age-related psychometrics of the MIDUS personality adjective items across the life span. *Psychological Assessment*, *24*, 173-186.

Zimprich, D., & Martin, M. (2002). Can longitudinal changes in processing speed explain longitudinal age changes in fluid intelligence? *Psychology and Aging*, *17*, 690-695.

Table 1: Summary of Available Studies on Correlated Change Within the Domain of the Big Five Personality Traits

Authors (year of publication)	Sample size (*N*)	Mean age/ range	Time interval	Time points	Measures	Analytical strategy	Change correlation (*M* Δ*r*, range)
Allemand, Zimprich, & Herzog (2007)	455; 420	43.7; 62.4	4 years	2	NEO-FFI	Multiple-group multivariate latent change models	.38 (.10-.63); .33 (.01-.57)
Allemand, Zimprich, & Martin (2008)	300	62.4	12 years	2	NEO-FFI	Multivariate latent change models	.38 (.001-.69)
Lüdtke, Roberts, Trautwein, & Nagy (2011)[a]	4,544[b]	19.5	4 years	3	NEO-FFI	Multivariate latent growth curve models	.23 (.01-.45)
Soto & John (2012)	125	21	40 years	5	CPI	Multilevel models	.09 (.01-.16)
Mõttus, Johnson, Starr, & Deary (2012)	209	81	6 years	2	IPIP	Multivariate latent growth curve	.17 (.02-.30)
Klimstra, Bleidorn, Asendorpf, van Aken, & Denissen (2013)	14,886; 174	17-94; 12	5 years	2	BFI-S; Bipolar adjectives	Multiple-group manifest cross-lagged models	.13 (.03-.26)[c]; .25 (.06-.43)
Mund & Neyer (in press)[a]	654[b]	18-30	15 years	2	NEO-FFI	Multivariate latent change models	.30 (.05-.65)

Note. Change correlations (Δ*r*) reflect absolute values (for the approach to calculate the mean change correlation (*M* Δ*r*), see Footnote 3); [a] the correlated change findings between the personality traits were not the primary focus of the study; [b] sample size at T1; [c] change correlations for the total sample; NEO-FFI: NEO Five-Factor Inventory (Costa & McCrae, 1992); CPI: California Psychological Inventory (Gough & Bradley, 1996);

IPIP: International Personality Item Pool (Goldberg, 1999); BFI-S: short version of the Big Five Inventory (Gerlitz & Schupp, 2005); Bipolar Adjectives: Personality measure based on bipolar adjective (Asendorpf & van Aken, 1999).

Figure 1: A Categorization Framework of Correlated Change.